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PROCESS DESCRIPTION DOCUMENT FOR THE ACCELERATED WASTE RETRIEVAL PROJECT

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Revision 1

ORIGINAL

FERNALD

Environmental Management Project

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TABLE OF CONTENTS

4750

ACRONYMS

API	American Petroleum Institute
AWR	Accelerated Waste Retrieval
AWWT	Advanced Wastewater Treatment
BOP	Balance of Plant
CATS	Conditioning and Transfer System
CCTV	closed circuit television
CFR	*Code of Federal Regulations*
DCS	Distributed Control System
D&D	decontamination and demolition
DOE	U.S. Department of Energy
FEMP	Fernald Environmental Management Project
FSMS	Full Scale Mock-Up System
FWENC	Foster Wheeler Environmental Corporation
HEPA	high-efficiency particulate air
HMI	Human-machine interface
I/O	input/output
PLC	programmable logic controller
RCS	Radon Control System
RD	remedial design
SWRS	Silo Waste Retrieval System
TTA	Transfer Tank Area
TWRS	TTA Waste Retrieval System
UPS	uninterruptible power supply

1.0 INTRODUCTION

Silos 1 and 2 are located at the U.S. Department of Energy (DOE) Fernald site near Cincinnati, Ohio. The silos store K-65 material, a residue that contains radionuclides, including radium (the primary contaminant of concern), generated in processing high-grade uranium ores.

As part of remediating Silos 1 and 2, waste material will be removed and staged into a shielded and ventilated storage tank system. Future plans specify transferring the K-65 material from the Transfer Tank Area (TTA) to the Silos 1 and 2 Remediation Facility for treatment prior to off-site disposal.

The current Fernald baseline schedule specifies the Silos 1 and 2 Remediation Facility to be constructed concurrently with the Accelerated Waste Retrieval (AWR) Project. The current schedule also reflects some degree of operational overlap between operating the AWR process and the Silos 1 and 2 Remediation Facility process. However, the Silos 1 and 2 Remediation Facility Project is not within the scope of the AWR Project or this document.

The AWR technical objectives and criteria are defined in "The AWR Technical Requirements Document, Doc. No. 40710-RP-001". In December 2000, the Foster Wheeler Environmental Corporation (FWENC) prepared a final design report supporting the AWR Technical Requirements Document. Based upon this design a Remedial Design (RD) Package was submitted to and subsequently approved by the U.S. Environmental Protection Agency and Ohio Environmental Protection Agency.

Subsequent to the December 2000 AWR Final Design submittal, FWENC's contract was terminated and Fluor Fernald, Inc., acquired the services of Jacobs to review, modify, and optimize the existing FWENC design in an effort to reduce project risk and enhance the probability of the AWR Project's success.

Based upon the Jacobs AWR design optimization efforts, a modified AWR design description has been prepared. The objectives of this document are the following:

1. Define the relevant Technical Baseline modifications;
2. Define the relevant AWR Design Basis modifications;
3. Define the major changes to the FWENC December 2000 Final Design as defined in the RD Package; and
4. Generally describe the modified AWR design in terms of the processes and equipment needed to achieve the applicable AWR Technical Baseline requirements.

2.0 DEFINITION OF AWR MODIFICATIONS

Modifications to the AWR Technical Baseline have been incorporated as a result of the design optimization process and to correct design deficiencies in the FWENC Final Design package discovered during the Due Diligence review process. Accordingly, these modifications have generated changes in the AWR Design Basis and ultimately the physical AWR design. These changes are defined below. The defined changes are in addition to or in clarification of those listed in the Fernald Environmental Management Project (FEMP) Baseline Closure Plan, Volume VII: Silos Project Silos 1 And 2, AWR Project, Change Proposal (40000-PL-0011), Revision 2, December 2001.

2.1 BASELINE SCHEDULE MODIFICATIONS

The Fernald Baseline Schedule has been modified to reflect concurrent construction of the AWR Facilities and the Silos 1 and 2 Remediation Facility. The Baseline Schedule also reflects concurrent operation of both facilities during the later phases of the AWR Project.

2.1.1 Resulting Design Basis Changes

The AWR design has been modified to include the capability to transfer waste from either Silo 1 or Silo 2 to any of the four transfer storage tanks while transferring waste material from any other transfer storage tank to the Silos 1 and 2 Remediation Facility. In addition, capability to pump material from one transfer storage tank to another is provided.

2.1.2 Resulting Physical Design Changes

1. A stationary bridge will be constructed over each silo to support silo waste retrieval operations.

2. Each silo bridge will be equipped with two sluice modules and one slurry/decant pump module.

3. Two sluice modules and one slurry/decant pump module will be installed on each transfer storage tank.

2.2 SILO CAP REMOVAL

In the FWENC design the 30-ft-diameter plywood and steel framing silo caps were to remain in place during Silos Waste Retrieval System (SWRS) activities.

However, these plywood and steel framing caps interfere with the silo waste retrieval equipment risers. Therefore, to mitigate this technical risk the silo caps will be removed prior to installing the SWRS equipment. Removing the caps to expose the concrete silo domes will facilitate installing new silo equipment access risers.

2.2.1 Resulting Design Basis Changes

The AWR design has been modified to include removing the 30-ft plywood and steel framing caps.

2.3 HEEL MATERIAL AND DISCRETE OBJECT REMOVAL FROM THE SILOS

Removing discrete objects and debris from the silos has been deleted from the AWR scope. Bulk waste retrieval operations will continue until the slurry pumps can no longer be operated effectively. Heel material is defined as material that cannot be removed readily using the AWR past practice sluicing technology. (Past practice sluicing utilizes a medium pressure (200 psi), high volume (300 gpm) liquid stream to dislodge, slurry, and convey waste material to the intake of a slurry pump.) The discrete objects and heel material will be removed using more direct techniques than the past practice sluicing technology. The heel material will be removed during AWR safe shutdown activities after completing bulk waste retrieval. The specific design of the heel removal system will be developed based upon the experience and actual data on the amount and condition of discrete objects and heel material gained during bulk waste retrieval.

2.3.1 Resulting Design Basis Change

There are no provisions to remove the heel material or discrete objects from the silos during the bulk waste retrieval phase of the AWR Project. The current concept for heel removal being considered by Fluor Fernald, Inc., and DOE EM-50 involves the use of a Remotely Operated Vehicle to move heel material into the silo sump pit, from which it would be pumped to the TTA. The specific details of discrete object and heel removal and final decontamination of the silos will be finalized based on information and experience gained during bulk waste retrieval and will be defined in the safe shutdown documentation submitted for regulatory review.

2.3.2 Resulting Physical Design Changes

1. The conditioning and transfer system (CATS) designed for heel removal and consisting of the silo (waste) retrieval end effector, a hose bundle, a jet pump, and the slurry pump heel attachments is eliminated from the design.

2. The debris removal system is eliminated from the AWR design.

3. The Easily Manipulated Mechanical Arm is eliminated from the AWR design because its primary function is to remove discrete objects and to assist with manipulating the silo waste retrieval end effector during the CATS heel removal activities.

2.4 HEEL MATERIAL AND DISCRETE OBJECT REMOVAL FROM SILO DECANT SUMP

The silo decant sump tank is located underground between the silos. The decant sump is known to contain a small quantity of residual sludge material. Similar to the situation involving the silo heel material, this residual sludge material would be difficult to remove using past practice sluicing; therefore the decant sump residual material will be removed during silo decontamination and demolition (D&D) activities. The details of decant sump tank solids removal will be defined in the Safe Silo D&D Project shutdown documentation submitted for regulatory review.

2.4.1 Resulting Design Basis Change

No provisions are required in the AWR design basis to remove the residual sludges from the silo decant sump tank. The AWR design basis does require that an automated level control and liquid removal system be placed in the decant sump during SWRS activities.

2.4.2 Resulting Physical Design Change

1. The Decant Waste Retrieval System is eliminated from the AWR design.
2. Silo decant sump tank liquid level instrumentation and capability to pump out accumulated liquid is maintained in the AWR design.

2.5 FULL SCALE MOCK-UP SYSTEM

The Full Scale Mock-Up System (FSMS) has been eliminated from the scope of the AWR Project. However, a cold test loop involving testing and optimizing AWR process equipment has been added to the scope of the AWR Project. The cold test loop is intended to simulate data to that expected from the FSMS.

2.5.1 Resulting Design Basis Change

1. No provisions are required for a full-scale mock-up of the AWR process at FEMP.
2. A cold testing system has been developed to demonstrate the key AWR design parameters and process equipment.

2.5.2 Resulting Physical Design Change

1. The FSMS, which includes all the process equipment associated with Silo 4, is eliminated from the AWR design.
2. A cold testing system to demonstrate the key AWR design parameters and process equipment has been developed. The key process parameters include materials of construction, deposition velocities, material conveying properties, design approach, and operation and control techniques. Key process equipment include sluice nozzles, slurry pumps, slurry instrumentation, and valves.

2.6 MODIFICATION OF AWR WASTEWATER MANAGEMENT STRATEGY

2.6.1 The Resulting Design Basis Change

The previous design basis specified treating AWR wastewater by one of three methods:

- Ultra-filtration with discharge to the Advanced Wastewater Treatment (AWWT) facility.
- Storing wastewater for radon decay and then discharge to AWWT.
- Treating wastewater in skid-mounted ion exchange and filtration units with discharge to the AWWT.

The modified Wastewater Management Plan specifies the following methods of wastewater dispensation:

- During Radon Control System (RCS) Phase I prior to the availability of the transfer storage tanks, condensate from the dehumidification system is stored in the condensate hold-up tanks for radon decay. After radon decay, the condensate is transferred to the AWWT for further treatment. The design of the condensate hold-up tanks is based on a radon decay stay time of 20 days and a condensate flow rate from desiccant dryers of 0.08 gpm. More information is provided in the RCS Phase 1 Mass Balance Table.
- At the time after construction the transfer storage tanks become available for use, condensate is pumped to the transfer storage tanks for use during sluicing operations.
- Excess water from bulk waste retrieval will be transferred to the Silos 1 and 2 Remediation Facility for storage pending use in the Silos 1 and 2 treatment process, or sampling and discharge to the AWWT.

2.7 RCS DESIGN CAPACITY—INCREASED TO 2,000 SCFM

2.7.1 Resulting Design Basis Change

The components comprising the RCS must be sized to adequately treat 2,000 scfm at the design conditions of 100 percent relative humidity and 95°F. The 2,000 scfm capacity will be utilized if expanded radon treatment is identified as necessary to support concurrent operation of bulk waste retrieval and the Silos 1 and 2 Remediation Facility.

2.7.2 Resulting Physical Design Change

The ducting and fans have increased in size to accommodate a process flow rate of 2,000 scfm. The drying system and the discharge high-efficiency particulate air (HEPA) filters have been reconfigured to allow parallel operation at 2,000 scfm.

2.8 DUCT HEATERS—ELIMINATED FROM THE RCS DESIGN

2.8.1 Resulting Design Basis Change

As a result of reevaluating both the original assumptions regarding the risk of igniting the carbon and the need to use heated air to provide adequate drying, the duct heaters are eliminated from the RCS design. An independent fire hazard analysis expert predicted an auto-ignition temperature for the carbon given the conditions expected in the RCS that is significantly lower than previously assumed (and lower than the drying temperature specified in the design). The modified design utilizes unheated, dried air from the desiccant dryer system, rather than heated air, to provide necessary drying.

2.8.2 Resulting Physical Design Change

Since the RCS design includes redundant desiccant dryers upstream of the carbon beds to dry all air entering the beds, the buildup of excessive moisture and the need to dry a bed are not expected to occur frequently. Therefore, radon monitors and moisture monitors will be used to monitor the condition and effectiveness of each bed. Based on the data from these monitors, the need to regenerate a bed will be identified and initiated. Regeneration will be accomplished by isolating the bed to be dried and recycling dried air from the desiccant drying system through the bed until sufficiently dried. The RCS provides sufficient excess carbon adsorption capacity to maintain specified emission limits while the impacted carbon bed is being dried.

3.0 SYSTEMS IDENTIFICATION AND DESCRIPTIONS

This section briefly describes the operating strategy and major process systems associated with successfully completing the AWR Project bulk waste retrieval operations. While Silos 1 and 2 contain two distinct layers of material that must be retrieved, the intent is simultaneous retrieval. The top layer is bentonite (trade name BentoGrout™) that was placed in the silos to prevent radon migration into the dome space and out of the silos. The bentonite layer varies, but in general is approximately 6 in. deep in the center of the silo and 3 ft deep near the silo walls. The material may have dried out on the surface and may still be wet near the bottom of the bentonite layer. The underlying K-65 material exceeds a 20 ft depth.

The AWR Project baseline consists of four distinct objectives:

- **Objective 1:** Construct a radon treatment system to reduce the radon concentration in the silo headspace before other AWR activities begin, and maintain safe radon concentrations during all AWR activities.

- **Objective 2:** Retrieve K-65 waste from the silos and transfer the waste material to a safe storage area. This objective is limited to bulk waste retrieval and does not address heel material or discrete object removal. Approximately 86,900 gal of heel material is projected to remain in the bottom of each silo following bulk retrieval.

- **Objective 3:** Stage K-65 waste in the TTA until it is transferred to the Silos 1 and 2 Remediation Facility.

- **Objective 4:** Retrieve K-65 waste from the TTA facility and transfer it to the Silos 1 and 2 Remediation Facility.

To accomplish these project objectives according to the current technical baseline the AWR Project includes the four major process systems listed below:

- **RCS** – The RCS controls and reduces radon concentrations in the silos and the AWR process facilities. The RCS consists of a ducting system, an air chilling/drying system, an activated carbon system, HEPA filtration, controls, and a monitored stack.

- **SWRS** – The SWRS utilizes a technique referred to as "past practice sluicing" to retrieve and transfer material from the silos. Past practice sluicing utilizes a medium pressure (200 psi), high volume (300 gpm) liquid stream to dislodge, slurry, and convey waste material to the intake of a slurry pump. The slurry pump conveys the slurried material to a storage facility. The AWR Project utilizes two sluicing nozzles and one 350-gpm centrifugal slurry pump in each silo. Each sluice nozzle is capable of supplying 300 gpm; however, a total of 300 gpm will be used for sluicing operations. The sluice nozzles and the slurry pumps are housed in sealed steel structures. The steel structures are supported on fixed bridge structures constructed over each silo. The sluice nozzles are located approximately 50 ft apart. The slurry pump is located between the sluice nozzles. The sluice nozzles and slurry pumps enter the top of the silos through engineered penetrations. The sluice nozzles and slurry pumps are designed to allow their placement through the entire vertical profile of the silos.

- **TTA System** – The TTA system consists of four 750,000-gal American Petroleum Institute (API) 650 carbon steel storage tanks located in a shielded concrete vault. Each of the tanks is ventilated to the RCS for radon control. The tank vaults are provided with leak detection and a means to remove liquid wastes. The K-65 waste will be stored in the TTA until it is transferred to the Silos 1 and 2 Remediation Facility.

- **Transfer Tank Area Waste Retrieval System (TWRS)** – The TWRS retrieves K-65 from the transfer storage tanks and transfers it to the Silos 1 and 2 Remediation Facility. Past practice sluicing is utilized to transfer the waste from the TTA in much the same manner in which it is removed from the silos. Two 300-gpm sluice nozzles and one 350-gpm slurry pump are provided for each transfer storage tank. The sluicing nozzles and slurry pumps are housed in sealed steel structures (equipment modules). The design of the sluicing and slurry systems comprising the TWRS is identical to those in the SWRS operation. During SWRS, the TWRS slurry pumps are used to provide sluicing water to the silo sluicing nozzles. Supernatant resulting from the settling of solids within the transfer storage tanks is used as sluice water.

3.1 SILOS 1 AND 2 WASTE RETRIEVAL SYSTEM

The SWRS retrieves K-65 waste, BentoGrout™, and residues from the silos and transfers them to the transfer storage tanks. Prior to initiating SWRS activities the plywood and steel caps are removed from the silo structures to expose the silo's concrete surface for ease of equipment installation. The silo dome cap will be retrofitted with engineered openings, through which SWRS equipment will access the K-65 material. Past practice sluicing techniques are used to recover the majority of waste from the silos. Three video cameras with lights that are deployed through risers into each silo roof provide the global view required to maneuver and control equipment during waste retrieval and assessments.

The SWRS main systems and components used with each system are:

- Silo 1, Sluicer Module No. 1
- Silo 1, Sluicer Module No. 2
- Silo 1, Slurry/Decant Pump
- Silo 1, Slurry/Decant Pump Module
- Silo 1, Slurry transport piping
- Silo 1, Closed-Circuit Television (CCTV) Video Cameras and Lights

- Silo 2, Sluicer Module No. 1
- Silo 2, Sluicer Module No. 2
- Silo 2, Slurry/Decant Pump
- Silo 2, Slurry/Decant Pump Module
- Silo 2, Slurry transport piping
- Silo 2, CCTV Video Cameras and Lights
- Silo High-Pressure Pump
- Diverter Valve Enclosure
- Silo Decant Sump Tank and Sump Pump
- Silo "C" Bridge

Bulk retrieval of the silo waste material is accomplished using sluice nozzles and a slurry pump. Each silo has its own dedicated bulk retrieval equipment. The silo slurry pump is located in a module on the bridge over the center riser of the silo. Each sluice nozzle is located in a separate module (total of two sluice modules per silo) on the bridge over the riser inline and approximately 25 ft to each side of the slurry module. Control valve automatic actuators are electric and normally controlled from the control room. Local control panels provide valve actuator control on the bridge decks. Sluice water is liquid decanted from the transfer storage tanks and will be supplied by the TTA slurry pumps.

Initially, the sluice nozzle stream(s) is directed as close to the slurry pump inlet as possible to create a slurry pool and form a cavity for slurry to flow into. The slurry pump is lowered into the cavity and turned on when sufficient submergence has been achieved. The slurry pump also has a high-pressure water jet ring at the pump suction that can assist in breaking up hard material into pumpable slurry. The sluice nozzle is used to create a sluice stream, which pushes material toward the pump. The width, depth, and length of the stream will be managed to maintain sluicing effectiveness while trying to minimize the diameter of the slurry pool around the slurry pump. When sluicing operations are complete, the slurry line and slurry pump are flushed with sluice water. If plugging occurs during normal operations, sluice water may be redirected to the slurry line to backflush the plug out of the line.

As the waste level in the silo decreases, the slurry pump is periodically lowered further into the tank, until it is at the small sump in the bottom. As the pump is lowered, instrumentation is monitored to ensure proper submergence before the pump is started.

The pump has a discharge pressure gauge and mass flow meter. The mass flow meter measures the slurry mass flow rate and density. It is equipped with a "net flow" computer that converts instrument measurements into a total mass of solids transferred through the slurry line. The mass flow rate and density measurements are used to monitor solids loading in the slurry line. The measurements are necessary to ensure that the slurry transfer pipeline flow rate is in the target range.

The sluice nozzle is lowered periodically as the waste level is decreased. Lowering the nozzle increases waste mobilization efficiency by impacting the waste at a more direct angle and shorter distance. The total sluice water flow is adjusted with the slurry pump discharge rate to achieve a steady state operation in the silo. The normal operating range is 300 to 350 gpm. The sluicer is equipped with pan and tilt capabilities for fine control of angle of impact.

There may be times when the sluice water flow nozzle is not adequately effective to dislodge the waste. The slurry pump has a high-pressure spray ring to assist in dislodging the hardened material. Liquid for the spray ring is supplied from the silo high-pressure pump. Spray ring operation is being evaluated as part of the AWR cold loop test.

3.1.1 Silo Sluicers

Each silo has two sluicers; each sluicer is installed in its dedicated module mounted on the bridge. Silo sluicer nozzles are approximately 15/16-in. inside diameter and normally operate alternately at 150 psi and 300 gpm. This creates a sluice stream having approximately 140 ft/sec velocity. Total sluice flow rate is fixed with a maximum total flow of 300 gpm whether operating one or two nozzles to maintain silo water balance during bulk retrieval.

Sluice nozzle size, flow, pressure, and operating configurations are part of the cold loop testing. Each nozzle is articulated remotely from the control room in an automatic or manual mode to allow for either vertical channel cutting or horizontal sweeping. Each sluicer is capable of rotating 340° horizontally and 105° vertically.

As waste level decreases, the two sluicers also have the ability to be lowered to achieve the proper angle of impact on the waste. Mast sections containing sluice water piping are added manually with the assistance of a hoist to raise and lower the nozzle. The mast hoist in each of the sluicer enclosures accomplishes fine adjustment of the nozzle elevation. The mast hoist normally is operated from the control room, but also may be operated locally when adding or removing sections.

3.1.2 Silo Sluicer Enclosures

The sluicer module houses the sluicing deployment system. The module also serves as secondary containment designed to drain into the silo. The module measures approximately 6 ft by 10 ft by 20 ft high. The enclosure weighs approximately 15,000 lb and has gloveport panels, an 11-ft by 3-ft access door and a 2-ft by 2-ft pass-through.

The silo bridge platform supports the weight of the sluicing system. The sluicing system is connected to the silo by a flexible coupling or bellows that allows for small vertical or horizontal bridge platform movement without inducing stresses to the silo.

When sluice nozzles are removed from the silos they are decontaminated by a high-pressure spray ring and passed through a radiation-monitoring ring. As the equipment is removed it is manually washed with a spray wand through the glove ports to ensure that it is properly cleaned. Water to the spray ring is supplied from the silo high-pressure water pump. The sluicer module has a large interface opening to allow the sluicing equipment to pass into and out of the silo.

3.1.3 Silo Slurry Pump

The slurry pump is a centrifugal-style, submersible sump pump. Normal operation of the pump is expected to be approximately 350 gpm and 200 psi during SWRS activities. The impeller and wear components are made of an abrasion-resistant material. A high-pressure spray ring is also mounted ahead of the pump's suction. The agitator and spray ring keep the solids in slurry form as well as help the pump "dig" into the K-65 and BentoGrout™ material. Additionally, a strainer screen plate is mounted ahead of the pump's suction to protect the pump from damaging debris entering it.

The pump is supported from a cable and winch system. The pump is variable speed to control and match flows with the other pumps. The drive motor is a super severe duty (Service Factor = 1.35), which requires 480 VAC, 60 Hz, three-phase power. The motor and pump assembly are mounted on a vertical-positioning system that is raised and lowered by an open loop, remotely controlled, single-speed AC drive motor. When the pump is lowered to the bottom of its travel, the assembly is manually secured and another section of mast is installed. Instrumentation indicates when the pump is resting on the waste material to prevent driving the pump into solid K-65 material. The total weight of the slurry pump system, support equipment, and enclosure is estimated at approximately 21,500 lb.

3.1.4 Silo Slurry Pump Module

The slurry pump module houses the slurry pump deployment assembly. The module also serves as secondary containment designed to drain to the silo. Currently, the module measures approximately 9 ft wide by 18 ft long by 20 ft high. The module has a horizontal-sliding carrier that assists with pump and mast section assembly and stowage. The module has multiple gloveport panels, a 12-ft 10-in. by 4-ft 4 ¼-in. access door, and a 2-ft by 2-ft pass-through.

The module contains pipe and valves needed to accomplish pumping and flushing operations. Valves and pipe will include motor-operated, multi-way ball valves and piping/hoses to direct the flows. The module also contains a spray ring to decontaminate the pump assembly when it is removed from the tank.

The weight of the slurry pump system is supported by the silo bridge platform. The slurry/decant pump system is connected to the silo by a flexible coupling that allows vertical or horizontal bridge platform movement without inducing stresses to the silo. When the slurry pump is retracted from the silo it is decontaminated by a high-pressure spray ring mounted at the bottom of the enclosure. Manual washing with a spray wand and radiation monitoring occur through the glove ports as the equipment is removed to ensure that the equipment is properly cleaned. The silo high-pressure water pump supplies water to the spray ring and manual spray wand.

3.1.5 Silo Slurry Transport Pipeline

The slurry transport pipeline is a pipe-in-pipe design that provides secondary containment. It is insulated and heat-traced. The pipeline also is equipped with systems to detect leaks and monitor line pressures. The pipeline is sloped toward the silos and toward the TTA from the diverter valve enclosure to allow gravity-draining.

The slurry transport pipeline extends from each of the silo modules to the diverter valve enclosure located on the support bridge connecting the two silo bridges. From the valve enclosure the slurry lines extends along a pipe bridge to the TTA Building until they terminate at the TTA diverter valve area in Containment Area A. The TTA valve area is located centrally to the transfer storage tanks. From the valve area the slurry is discharged into the transfer storage tanks. If plugging occurs during normal operations, sluice water is to be directed into the slurry line to clear the blockage. Capability is provided for forward flushing and backflushing to clear a clogged line. In addition to flushing capability, clean-outs are provided in the transfer piping at strategic locations between the silo bridges and the TTA. A spare slurry transfer line also is provided so that if one line becomes plugged, operations may continue until the end of the operating period.

Pressure transmitters, which are monitored in the control room are located at intervals along the transfer piping and used to determine the location of the blockage. Once the approximate location of the blockage is pinpointed, the line will be flushed by using a quick disconnect to remove blockage.

The slurry pump is equipped with an inlet screen plate to minimize the size of debris. Therefore clogs will most likely consist of K-65 and BentoGrout™ material. This material will remain in the pipe and be flushed to the transfer storage tank after the blockage has been cleared.

3.1.6 Silo Bridge

A steel bridge structure supports all silo equipment modules, skidded equipment, and pipe. The bridge is a stationary "C" shape with each leg of the "C" extending out over each of the silos. Bridge design considers safe access to the modules and other equipment as well as operations and maintenance activities.

The diverter valve enclosure is located at the center of the bridge. The enclosure contains motor-operated diverter valves that are fitted with flange guards to deflect spray that might occur from a leaking joint.

3.2 MANAGING SILO DECANT SUMP TANK DURING SWRS

The silo decant sump tank is located underground and just west of and between the silos. It is a carbon steel, 9,000-gal, 18-ft-long, and 9-ft-diameter cylindrical tank with dished ends. The tank is buried horizontally with a 20-in. opening centered at the top of the tank. A 30-in. corrugated manway centered over the 20-in. opening extends approximately 33 ft to the ground surface.

Before silo waste retrieval is initiated, a submersible pump and liquid level monitoring instruments are installed to control tank level. The level monitoring system is designed to monitor both level of liquid in the tank and the rate of level change in the tank. If the level set points are exceeded, the level monitoring system annunciates alarms. At that point, the operator will decide whether to start the silo decant sump tank sump pump, reduce or stop, sluice water flow to the silo, or both. The sump pump transfers liquids to the transfer storage tanks. The sump pump automatically shuts down on low level in the silo decant sump tank.

3.3 TRANSFER TANK AREA SYSTEM

The purpose of the TTA System is to stage residues received from Silos 1 and 2 for transfer to the Silos 1 and 2 Remediation Facility, which is located immediately east of the TTA. The TTA consists of a building that houses four 750,000-gal storage tanks, piping, a valve network for receiving and transferring slurried material, and slurry and sluice equipment. The TTA System supports both SWRS and TWRS operations.

The TWRS main systems and components used with each system are:

- Transfer Storage Tank 001A
- Transfer Storage Tank 001A Slurry/Decant Module
- Transfer Storage Tank 001A Sluicer Modules 1 and 2
- Transfer Storage Tank No. 001A CCTV Video Cameras and Lights
- Transfer Storage Tank 001B
- Transfer Storage Tank 001B Slurry/Decant Module
- Transfer Storage Tank Sluicer Modules 1 and 2
- Transfer Storage Tank 001B CCTV Video Cameras and Lights

- Transfer Storage Tank 002A
- Transfer Storage Tank 002A Slurry/Decant Module
- Transfer Storage Tank 002A Sluicer Modules 1 and 2
- Transfer Storage Tank 002A CCTV Video Cameras and Lights
- Transfer Storage Tank 002B
- Transfer Storage Tank 002B Slurry/Decant Module
- Transfer Storage Tank 002B Sluicer Modules 1 and 2
- Transfer Storage Tank 002B CCTV Video Cameras and Lights
- Equipment Deck
- Transfer Storage Tank Transfer Piping and Diverter Valves
- TTA Containment Area A
- TTA Containment Area B
- Transfer Storage Tank Leak Detection Sump
- Make-up Water Tanks
- Make-up Water Pumps
- TTA High-Pressure Pump

3.3.1 Transfer Storage Tanks

The carbon steel transfer storage tanks each have a capacity of 750,000 gal and are constructed in accordance with API 650. The design life of these tanks is 20 years. The tank volume allows for a maximum settled storage level of 90 percent of total capacity, although the tanks are designed for filling to their maximum capacity. The tanks are 66 ft in diameter, have a straight side dimension of 30 ft, and are provided with 1/4-in. corrosion allowance and an internal Plasite corrosion coating. The tank roofs are dome-shaped and are supported by rafters to minimize the overall height to 33 ft 6 in. (excluding nozzle risers) from the top of their concrete foundations. The tank bottoms are sloped to a center sump to facilitate residue removal during TWRS operation.

The four 750,000-gal storage tanks are connected at their overflow nozzles by a 6-in.-diameter pipe. This overflow arrangement together with the use of level measurement devices in each tank minimizes the potential of exceeding the capacity of any one tank. All four tanks are ventilated to the RCS, which is operated to maintain pressure in the tank headspaces between –2.0 and +0.5 in. W.C. Pressure and vacuum relief devices provide additional (backup) pressure and vacuum relief. The pressure relief devices include position switches tied the PLC to detect if a release has occurred.

Tank nozzles, except for the overflow, are located on the tank roof. The roof nozzles are parallel to the tank vertical axes and extend through sleeves in the equipment deck. Flexible boots are attached to the nozzles and the floor of the equipment deck to isolate the tank enclosure. These boots provide an air seal and allow independent movement between the deck and the nozzles, thereby virtually eliminating reaction forces and moments to the tank.

Each tank is provided with the following roof nozzles:

- One 48-in.-diameter nozzle located in the center for the slurry/decant pump
- Two 20-in.-diameter nozzles located 180° apart for the sluicer modules
- One 20-in.-diameter nozzle for the RCS inlet
- 12-in.-diameter nozzles are used for the level switch, pressure differential transmitter, process and waste water, and camera and light; two spares remain available
- Three 6-in.-diameter nozzles for level, slurry inlet, and RCS outlet
- One 12-in.-diameter nozzle for relief/vent
- One 6-in.-diameter nozzles overflow, located in the shell

Tank design includes 1/4-in. corrosion allowance above that required for stress, coating the interior surface with a 30 mils dry film thickness Plasite protective coating and painting the tank exterior steel surfaces. The decision to use and the choice of interior coating is based on the K-65 corrosion test results and a 20-year design life. The tanks are housed completely within a concrete and steel enclosure. The tanks are grounded to the TTA grounding grid, which maintains building steel, including reinforcing steel, and components at the same electrical potential.

3.3.2 Transfer Storage Tanks Enclosure

The transfer storage tanks enclosure is a concrete structure that provides secondary containment of stored wastes and radiation shielding. This structure is 152 ft long, 152 ft wide, and approximately 40 ft tall with concrete walls for radiation shielding. Sealing the concrete floor and the walls to a level 8 ft above the floor provides secondary containment. This containment is equivalent to 100 percent of the volume that liquid from one 750,000-gal tank would occupy.

The floor is sloped to a centrally located sump to facilitate detecting leaks and removing spills. A tank foundation sump under each tank collects any leakage that may occur through or around the tank bottoms. The four tank foundation sumps gravity-drain to the main enclosure sump through piping embedded in the tank foundation pads. Access to the sump pump is through an opening in the diverter valve containment area located on the equipment deck above the main sump. The main sump is equipped with level instruments for spill detection. The sump pump discharge piping is routed back to the transfer storage tanks. Each tank has an exposed bottom sump drain line that empties into the central sump trench, thus allowing the operator to identify which tank is leaking by the camera system, which can view all four sump lines.

If a leak is observed, the sump pump is used to transfer liquid from the sump to a non-leaking TTA tank. The TTA tank and piping system also allow liquid transfer from any of the four tanks to any other of the four tanks. This provision allows the contents of a leaking tank to be transferred to the remaining three tanks if a leak were to be observed.

3.3.3 Equipment Deck

The equipment deck covers the storage tanks. A steel column and beam system is designed to support the equipment deck and equipment loads supports the equipment deck. The support steel is primed and painted. The floor is concrete over steel. The equipment deck provides partial radiation shielding from the stored residues.

A loading platform is provided on the southern side of the TTA. The loading platform is fitted with a monorail-type hoist for use when tools and equipment parts are to be taken in or removed from the TTA. Access to the equipment deck is provided through a 16-ft-wide, 24-ft-high roll-up door. Two staircases provide access and egress to/from the equipment deck. One staircase is on the northern end of the eastern side of the TTA, and the other adjacent to the loading platform on the southern side of the TTA.

3.3.4 Equipment Deck Enclosure

The equipment deck enclosure is a pre-engineered metal building constructed over the equipment deck to protect the TTA equipment and manage precipitation. Rain and melting snow are directed to the storm drainage system. The deck enclosure is insulated and equipped with heaters to maintain a target temperature of 55°F during cold weather. Louvers and fans provide cooling ventilation during warm weather.

Personnel typically occupy the equipment deck area only when lines have been flushed and the transfer systems have been shut down for maintenance. The deck enclosure is also provided with doors, lights, gutters, and downspouts. Compressed air and process water are routed around the perimeter of the enclosure with several stations to support maintenance activities.

3.3.5 TTA Transfer Piping

Sluice and slurry transfer piping is double-walled, except within the diverter valve containment areas and modules. Outdoor pipelines are insulated and heat-traced. The pipeline is also provided with systems to monitor pipeline pressures and measure slurry density.

Two containment areas are located on the TTA equipment deck. Within these areas, piping is single-walled and enables use of flanged joints for valves and equipment. The flanges within these areas are fitted with flange guards to prevent spray from leaking joints. These areas are provided with sloped bottoms, sumps equipped with level instrumentation, and sump pumps. The sump pumps discharge collected liquids to the transfer storage tanks.

3.3.6 TTA Containment Area A

Containment Area A is located on the northern side of the TTA equipment deck. Diverter valves are located in Containment Area A. This area is provided with a sloped bottom, level instrumentation, and a sump pump. The sump pump discharges collected liquids to the transfer storage tanks.

3.3.7 Transfer Storage Tank Area Containment Area B

Containment Area B is located centrally on the TTA equipment deck. This area also provides access to the leak detection sump. This area is provided with a sloped bottom, level instrumentation, and a sump pump. The sump pump discharges collected liquids to the transfer storage tanks.

3.3.8 Make-Up Water Tanks

One 10,000-gal and two 7,500-gal make-up water tanks (TNK-50-001, TNK-50-002, and TNK-50-003, respectively) provide process water storage. The tanks are equalized, acting as a single water source, but may be isolated in case one tank needs to be out of service for maintenance or other reasons. The three tanks are installed so that the tank top are at the same elevation. This allows the tanks to have the same overflow level. The tanks are equipped with liquid level instruments to control the domestic water fill valve.

The tanks are constructed in accordance with API 650. They have flat bottoms supported on a concrete foundation. Corrosion considerations include painting external tank steel surfaces and providing a corrosion allowance of 1/16 in. Additionally, the interior of these tanks will have a 30-mil dry film thickness of Plasite coating.

3.3.9 Make-Up Water Pumps

Make-up water is transferred from the make-up water tanks by one of two centrifugal pumps located adjacent to make-up water tanks. The make-up water pumps transfer process water to the Remediation Facility, RCS, Silos 1 and 2, transfer storage tanks, and the high-pressure pump skid. The programmable logic controller (PLC) automatically stops the pumps on low tank level.

3.3.10 Slurry/Decant Pumps

The slurry/decant pumps, used to supply supernatant for silo sluicing and also to retrieve slurry from the transfer storage tanks, are deployed from their modules located over the center nozzle of each transfer storage tank. Slack hose and cable are suspended in the tank with enough length to allow the pump to reach the bottom of the tank. As the tank is filled and the pump is raised, lengths of cable and hose are disconnected and retracted from the riser.

There are four independent slurry/decant pump systems. One slurry/decant pump is dedicated to each transfer storage tank. This arrangement allows operational and water management flexibility.

The slurry/decant pump is a centrifugal-style, submersible sump pump. The pump normally delivers 300 gpm at 200 psi to achieve 150 psi at the silo sluicing nozzles. The impeller and wear components are made of abrasion-resistant material. An agitator and high-pressure spray ring are included ahead of the pump suction. The agitator and spray ring keep the solids in a slurry form as well as help the pump "dig" into the K-65 and BentoGrout™ material. The spray ring shuts off during sluicing supply operations. Additionally, a strainer screen plate is mounted at the pump suction to protect the pump from damaging debris entering it. The slurry/decant pump drive motor is a super severe duty (Service Factor = 1.35), requiring 480 VAC, 60 Hz, three-phase power. The pump is provided with variable speed control to allow for flow control. The total weight of the slurry pump system, support equipment, and enclosure is estimated at approximately 21,500 lb.

3.3.11 Slurry/Decant Pump Module

The slurry/decant pump module is built with a structural steel tubing frame, with steel sheet metal welded to the frame. It has one airtight access door, one equipment pass-through door, and sufficient gloveports and windows to allow equipment maintenance. The enclosure contains the equipment needed to allow the pump to function. Equipment includes a hoisting mechanism to install and remove the pump from the tanks, one hose reel to hold the pump discharge hose, one cable reel to hold the pump motor wiring, and motor-operated multi-port valves and piping to direct flows. The enclosure also contains a spray ring to decontaminate the pump assembly when it is removed from the tank. The circuit breaker box and terminal strip box for the electric components and motors are located on the outside wall of the enclosure.

The enclosure serves as secondary containment and drains to the storage tank. An air inlet damper is provided with HEPA filtration. The enclosure is connected to the RCS by connection to the transfer storage tank to provide enclosure atmosphere control.

3.3.12 Transfer Storage Tank Sluicers

Each TTA tank has two sluicers installed in it. Each sluicer is contained in a steel module, which is mounted on the equipment deck. To maintain sluice water balance during bulk retrieval, the total sluice flow rate is fixed whether operating one or both sluice nozzles. Each of the nozzles are remotely articulated from the control room in an automatic or manual mode to allow either vertical channel cutting or horizontal sweeping as necessary. Each sluicer has a 340° horizontal rotation and 105° vertical rotation capability.

As the level of the waste decreases, the TTA sluicers may be lowered to achieve the proper angle of impact on the waste. Sections of mast containing sluice water piping are manually added with the assistance of a hoist to raise and lower the nozzle. The mast hoist in each of the sluicer enclosures accomplishes fine adjustment of nozzle elevation. The mast hoist is normally operated from the control room but may also be operated locally when adding or removing sections.

The sluicing deployment system for the TTA sluicers is housed in a sluicer module. The module serves as secondary containment and drains to the transfer storage tank. Modules measure approximately 6 ft by 10 ft by 20 ft high. The module weighs approximately 15,000 lb and has several gloveport panels, an 11-ft by 3-ft access door, and a 2-ft by 2-ft pass-through. The weight of the sluicing system is supported on the TTA equipment deck. The sluicing system is connected to the transfer storage tank by a flexible coupling or bellows that allows small vertical or horizontal movement without inducing stresses to the transfer storage tank.

The TTA sluicers are removed from the transfer storage tank while being decontaminated by a high-pressure spray ring and then passed through a radiation-monitoring ring. As the equipment is removed it is manually washed with a spray wand through the glove ports to ensure that it is properly cleaned.

3.4 TRANSFER STORAGE TANK WASTE RETRIEVAL SYSTEM

The TWRS is designed to access, mobilize, and transfer waste residue stored in the TTA System. The function of the TWRS is to provide the capability to retrieve and transfer the entire inventory of waste from the transfer storage tanks to the Remediation Facility for final treatment process. Each transfer storage tank is provided with two sluicing systems and a slurry pump system. The equipment on each transfer storage tank and on the silo bridges is of the same design and fully interchangeable. During TWRS activities, the slurry/decant pump is operated as a slurry transfer system rather than as a sluice water system. To accomplish slurry transport, variable speed pump controls are used to adjust the discharge of the pump to 350 gpm at approximately 200 psi.

Equipment is provided to transfer stored residues from any one of the four transfer storage tanks to any other transfer storage tank. Motor-operated diverter valves with flange connections are provided for connecting slurry and sluice water piping. Sluice water for TWRS operations are supplied from the Silos 1 and 2 Remediation Facility. The TTA

System provides piping and valves between the new Remediation Facility interface point and each of the four transfer storage tanks. The two sluicer modules and the slurry/decant pump module are connected to each storage tank so that any transfer storage tank can be emptied as another is filled. The operation is repeated until the four tanks are emptied.

Personnel access is restricted during retrieval operations. Cameras observe placement of each sluicer nozzle to permit remote operation. Controls are provided to limit individual exposures to less than the permissible yearly limit. Operating controls for the TWRS are included in the control room. These controls allow the shutdown or start-up of TWRS equipment. Local controls for the TWRS subsystems are provided on the TTA equipment deck.

Automated functions of the TWRS are controlled by a PLC. These controllers process system events that require alarming. Local evacuation alarms are staged on the TTA equipment deck. The alarms also may be activated from the control room. Alarms are recorded and annunciated locally and in the control room.

3.5 WASTE RETRIEVAL OPERATING MODES

The AWR Project encompasses multiple modes of operation as the K-65 material is transferred from the silos to the TTA and ultimately to the Silos 1 and 2 Remediation Facility.

For the AWR Project, the silos, Transfer Storage Tank System, and Remediation Facility are designed to operate in three possible general configurations – SWRS, TWRS, and combined SWRS and TWRS. The valve configuration creates this operating flexibility. In addition, transferring waste from one transfer storage tank to another is possible.

3.5.1 SWRS Mode

In this mode, supernatant (sluice water) is pumped from one transfer storage tank to the sluice nozzle(s) in one silo, while slurry retrieved from that silo is pumped to a different transfer storage tank. The concept (see Figure 3.5.1) depicted is to use supernatant from one transfer storage tank to retrieve slurry from one of the silos. The slurry will be pumped into a different transfer storage tank and allowed to settle. In the SWRS mode, supernatant, if available, is pumped from any of three transfer storage tanks and supplied to either silo. Depending on the level in a particular transfer storage tank, retrieved slurry could be pumped to any transfer storage tank except the tank from which supernatant is being drawn. In this operating configuration, one silo and two transfer storage tanks are operating, and the other silo and two transfer storage Tanks are idle.

When slurry transfer is complete, sluice water or process water is used to flush the slurry lines between the silo and transfer storage tank.

3.5.2 TWRS Operating Mode

In this mode, supernatant (sluice water) is pumped from the Remediation Facility to the sluice nozzle(s) in one transfer storage tank, and slurry retrieved from that tank is pumped to the Remediation Facility. The concept (see Figure 3.5.2) depicted uses supernatant from the Remediation Facility to retrieve slurry from any one of the four transfer storage tanks. In this configuration, one transfer storage tank is operating and both silos and three transfer storage tanks are idle.

When slurry transfer is complete, sluice water or process water will be used to flush the slurry lines between the silo and transfer storage tank and the Remediation Facility.

3.5.3 Concurrent SWRS and TWRS Operating Mode

In this mode, two operations are occurring concurrently (see Figure 3.5.3). Supernatant (sluice water) is pumped from the transfer storage tank to the sluice nozzle(s) in one silo, while slurry retrieved from that silo is pumped to a different transfer storage tank. Simultaneously, supernatant (sluice water) is pumped from the Remediation Facility to the sluice nozzle(s) in a third transfer storage tank, and slurry retrieved from that tank is pumped to the Remediation Facility. This operation allows one transfer storage tank to operate in the decant mode, in which slurry water and slurry solids separate to generate supernatant on top of the slurry material.

When slurry transfer is complete, sluice water or process water is used to flush the slurry lines between the silo and transfer storage tank and the Remediation Facility.

3.6 RADON CONTROL SYSTEM

The RCS receives off-gases from the following sources: the silos, SWRS, TWRS, the TTA System, and the Silos 1 and 2 Remediation Facility. The RCS removes radon from gas streams, reduces radon releases to the atmosphere, monitors all releases to the atmosphere for radon and other radiological material, and mitigates system upsets. The RCS is constructed in two phases:

- RCS Phase 1 reduces and controls radon concentrations in the silo headspaces prior to construction in the silos area and prior to the initiation of waste retrieval.
- RCS Phase 2 reduces and controls radon concentrations in the associated Silos Project Facilities (i.e., TTA, Silos 1 and 2 Remediation Facility).

Figure 3.5.1

Silo Waste Retrieval System (SWRS) Operating Mode

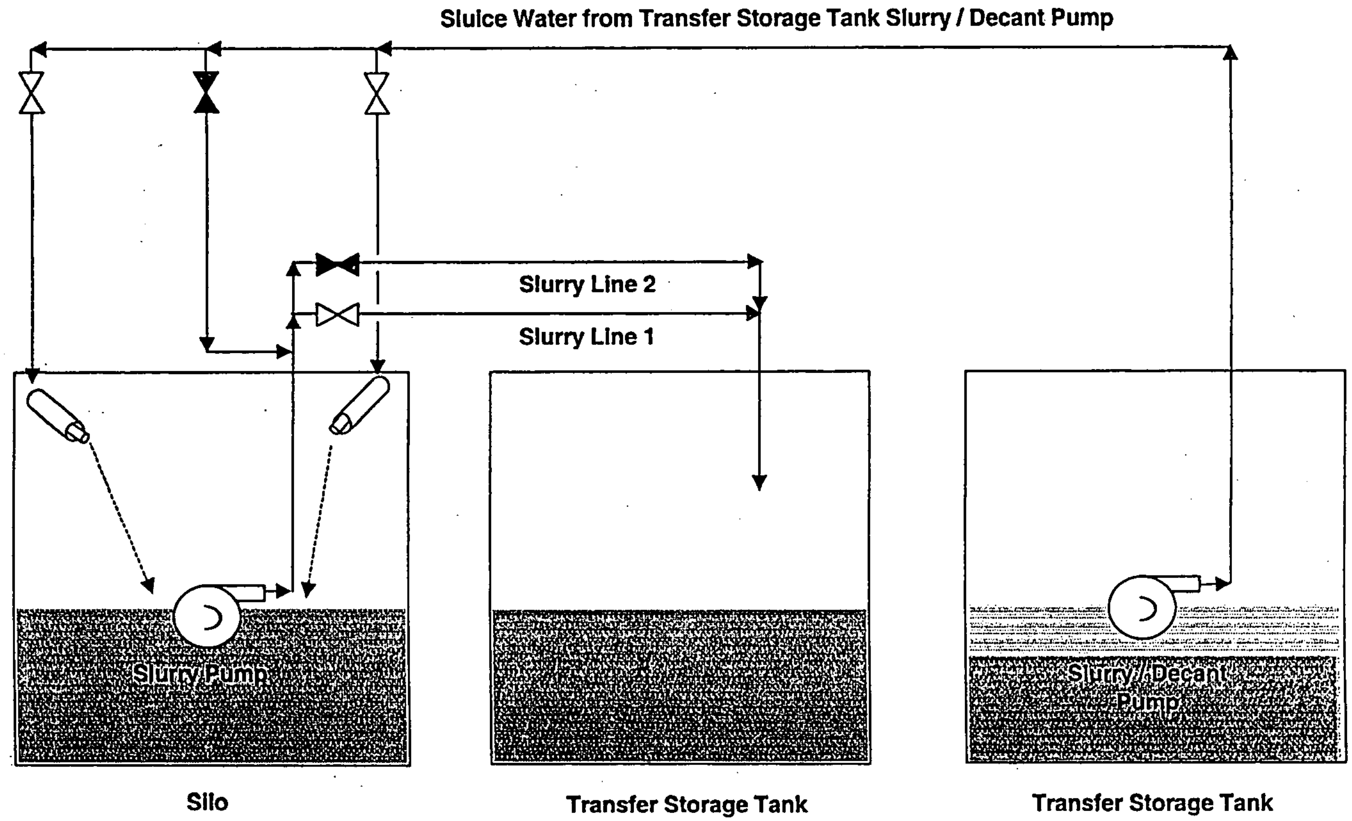

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Figure 3.5.2
Transfer Storage Tank Waste Retrieval System (TWRS) Operating Mode

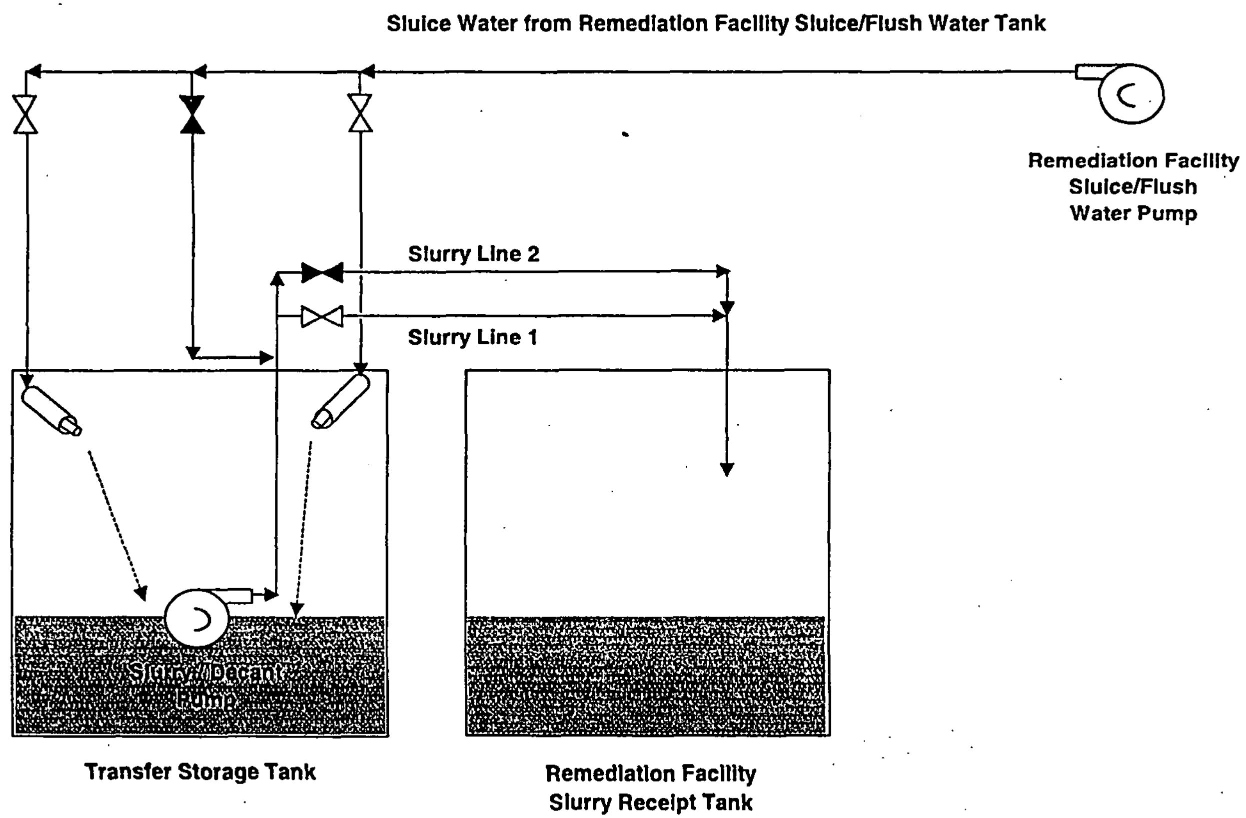

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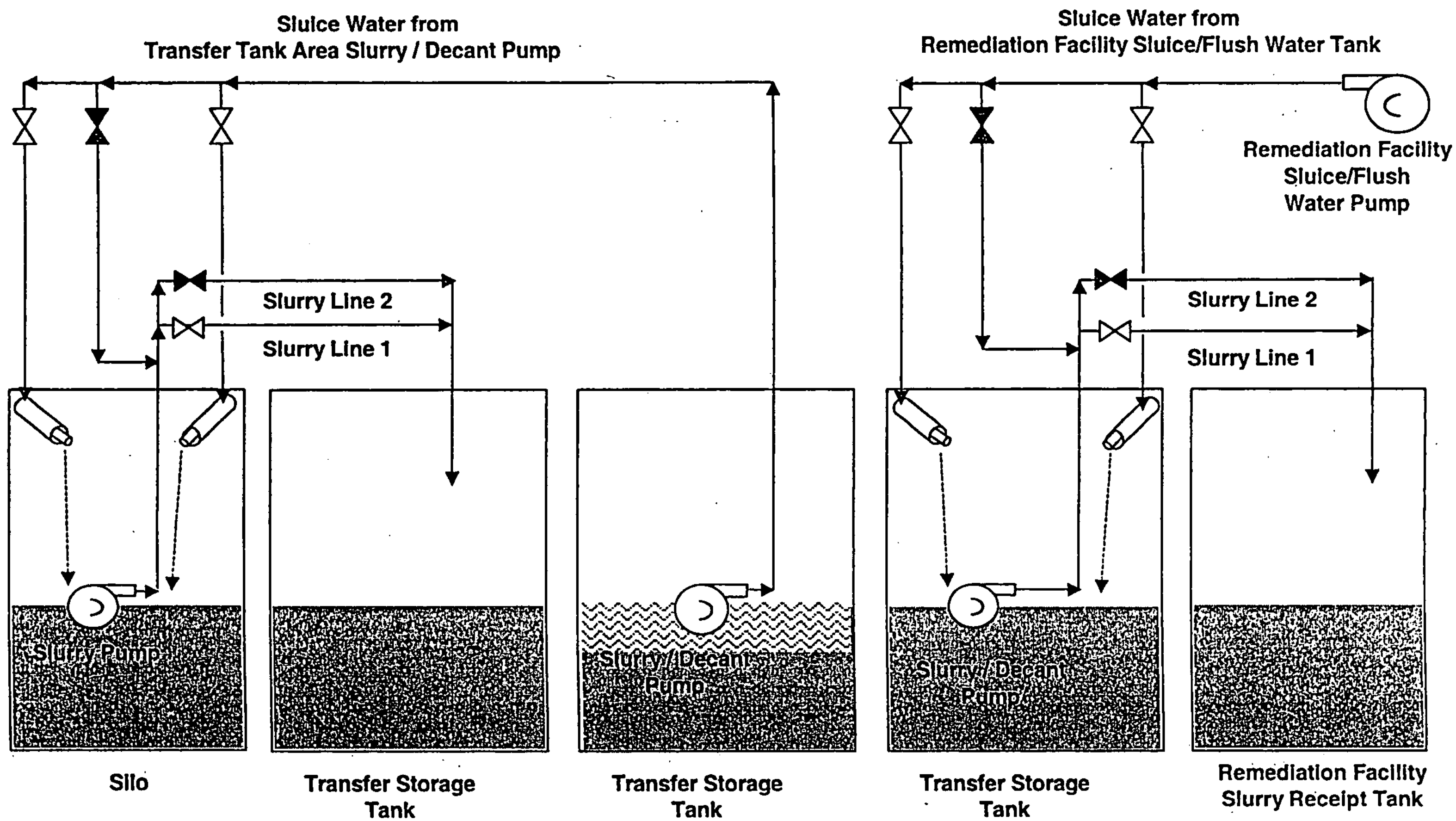
Figure 3.5.3
Concurrent Silo Waste Retrieval System (SWRS) and Transfer Tank Area Waste Retrieval System (TWRS) Modes



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3.6.1 RCS – Requirements

The RCS is designed according to the following requirements and criteria.

- Prevent over/under pressurization beyond -5.0 in. W.C. and +5.0 in. W.C. in the silos and -2.0 in. W.C. and +2.0 in. W.C. in the transfer storage tanks.
- Maintain radiation fields on the silo dome surface below 10 mrem/hr during construction periods of Phase 1 and during all periods of Phase 2.
- Provide sufficient shielding and exclusion area fence to maintain the area outside the RCS facility as a Radiation Access Zone 1 (less than 0.4 mrem/hr) during all phases.
- Ensure that there are no uncontrolled releases of radon to the atmosphere.
- Provide local evacuation alarms.
- Provide both local and remote monitoring and control to verify RCS process control.
- Provide a design life of 20 years.
- Provide isokinetic sampling, monitoring, and recording on all stack exhaust streams to atmosphere in accordance with 40 *Code of Federal Regulations* (CFR) Part 61, Subpart H. Provide remote alarm capability to indicate buildup of radioactive particulate. Provide continuous monitoring of the stack exhaust radon concentration.
- Maintain radon emissions from the exhaust stack below the level resulting in an annual average concentration of 0.5pCi/L above background at the FEMP fence line.
- Provide safe shutdown, secure stand-by, and restart capability.

3.6.2 RCS–Process Description

The RCS includes two separate treatment equipment configurations or phases. During Phase 1, the RCS is operated as needed to reduce and control silo headspace radon concentration during construction until the SWRS is operational. Phase 1 recycles air from the silo headspaces through a radon treatment system to reduce headspace radon concentration. After the radon count is reduced in the headspace and waste transfer is ready to begin, additional equipment will be added to the Phase 1 equipment for conversion to the Phase 2 system.

Phase 2 controls radon during waste removal, transport and staging in the TTA. Phase 3 operation supports transfer from the TTA and operation of the Silos 1 and 2 Remediation Facility. The fans and other equipment are designed to support concurrent operation of bulk waste retrieval and the Silos 1 and 2 Remediation Facility with a total flow of 2,000 scfm. Additional carbon beds may be added to support operation at 2,000 scfm, if identified as necessary based upon data collected during Phase 1 operation. The Phase 2 and 3 Systems are designed to provide a minimum of 25 ft per minute minimum capture velocity during events in which contaminated areas are opened to the atmosphere.

Phase 1 is a recirculating system operating four carbon beds in a parallel configuration. Each carbon bed contains 40,000 lb of carbon. Headspace air is drafted from the silos at 250 to 500 scfm per silo and combined into one air stream. Also, fresh air may be drawn into the system as make-up. The combined air stream flows through a dehumidification and chilling system to remove excess moisture and chill the air to approximately 45°F. The chilled air flows through a desiccant drying system to remove the remaining moisture. The air stream flows through another cooler to cool it to 40°F prior to entering the carbon beds. The air stream (conditioned to 40°F and 15 percent relative humidity) flows through the carbon beds for radon removal. The four carbon beds are connected in parallel, each receiving a flow of 250 scfm. The headspace air is monitored for radon both upstream and downstream of the carbon beds to determine the removal efficiency. Upon exiting the carbon beds the air stream flows through the recirculation fan before being returned to the silo headspaces.

Phase 2 is designed as a once-through treatment system using the same process equipment as that described for Phase 1. During Phase 2 the recirculation fans are utilized to produce an induced draft ventilation stream through the silos, TTA tanks condensate tanks, and the various equipment modules. During normal Phase 2 operations the treated air stream will flow through the carbon beds and HEPA filter train and exhaust through a monitored stack to the atmosphere. The system will be operated in such a way as to minimize the amount of make-up air required. If abnormal radiological conditions are detected at the stack, the RCS activates an alarm and the operator will take corrective action.

During Phase 3 the RCS operates in the same manner as Phase 2 except Silos 1 and 2 Remediation Facility ventilation is added to the RCS treatment process. Adding Silos 1 and 2 Remediation Facility ventilation might increase the flow; therefore the RCS has been designed to accommodate this possible increased capacity to 2,000 scfm.

Additional carbon beds may be added during Phase 2 to enhance the radon removal capabilities. The need for additional carbon beds will be evaluated during Phase 1 operation.

The 500 scfm vent rate from each silo is expected to maintain the silo headspaces at less than 500,000 pCi/L based on pre-bentonite rates of radon emanation into the silo headspaces. The 160,000 lb of carbon is designed to keep radon emissions to atmosphere to less than 0.2 Ci/day per silo.

3.6.3 Air Drying and Cooling

Previous radon control studies have indicated that the efficiency of radon adsorption onto carbon is enhanced when moisture and temperature are reduced. This air conditioning system is common to all phases of the RCS operation. The air drying and cooling system is composed of three components: condenser, air dryer, and cooler. The air drafted from the silos flows through a water-cooled condenser. The air temperature is reduced to 40°F saturated air based on inlet conditions of 75°F air at 100 percent relative humidity. This operation removes the readily condensable moisture and helps to minimize the required capacity of the air dryers. The air dryers use desiccant to remove the remaining moisture from the air stream. Using desiccant to dry the air increases the air stream temperature above the optimum temperature for removing radon with carbon beds. Therefore, prior to entering the carbon beds, the air stream flows through a cooler. The conditioned air enters the carbon beds at 40°F and 15 percent relative humidity.

3.6.4 Carbon Beds

Radon is a radioactive inert gas with a short half-life (3.82 days). Because radon is an inert gas, it does not react with other chemicals. Radon has an affinity for activated carbon. Activated carbon traps radon and allows it to decay to its daughter products. For the carbon beds to be effective, the air must be cool and dry as it enters. Phases 1 and 2 use four carbon beds operated in parallel. If required, Phase 3 may add additional beds to the system. Each carbon bed includes a 15-ft-long by 10-ft-wide by 10-ft-high steel shell containing 40,000 lb of activated carbon.

The RCS design includes redundant desiccant dryers upstream of the beds to dry all air entering the carbon beds. Buildup of excessive moisture and the need to dry a bed are not expected to occur frequently. Radon monitors and moisture monitors are used to monitor the condition and effectiveness of each bed. Based on the data from these monitors, the need to regenerate a bed is identified and initiated. Regeneration is accomplished by isolating the bed requiring drying and recycling dried air from the desiccant drying system through the bed until it has been sufficiently dried. The RCS provides sufficient excess carbon adsorption capacity to maintain specified emission limits while the impacted carbon bed is being dried.

3.6.5 HEPA Filter Train

All gasses discharged from the RCS flow through a HEPA filter system downstream from the carbon units to remove particulate material prior to exhausting through the stack. The HEPA filters trap fine particulates and typically have an efficiency rating of 99.97 percent for 0.3-micron particles.

The HEPA filters are housed in a steel frame. They are single-stage HEPA filters with 35 percent pre-filters. The HEPA housings are designed for bag-in/bag-out filter changes and are equipped with HEPA in-place test ports, static pressure taps, and lifting lugs.

3.6.6 Stack and Monitor

The exhaust stack is located adjacent to and west of the RCS building. The stack is constructed of carbon steel and is approximately 150 ft tall. The stack is equipped with both continuous radon and isokinetic particulate monitoring. Isokinetic monitoring will include continuous flow recording. Scaffolding and equipment platforms to support the monitoring in accordance with 40 CFR Part 60, Appendix A, Method 1, are included in the design.

3.6.7 RCS – Facility Description

The RCS facility houses RCS process equipment and the carbon beds. This includes the desiccant drying system, condensate holdup tanks, filters, and fans. The carbon beds are located in precast concrete vaults adjacent to the building. Vaults are provided with shielded walls. The concrete vaults are designed in a modular fashion so that additional carbon beds can be added with minimal down time. The first floor of the RCS building houses the roughing filters, chilling coils, desiccant dryers, and condensate tanks. The first floor area is provided with 2-ft-thick walls for shielding to be as low as reasonably achievable compliant. The RCS building is ventilated and heated to maintain appropriate operating temperatures. The RCS building ventilation system maintains the RCS building at a negative pressure relative to the atmosphere and ensures that airflow through the building is directed from less contaminated areas to more contaminated areas. Floors provide secondary containment for the condensate hold-up tanks. The carbon bed vaults are provided with an independent ventilation system designed to maintain the carbon beds at 60°F or less. Air flowing through the RCS building is discharged from the monitored RCS stack.

4.0 AWR SUPPORT SYSTEMS

4.1 CONTROL SYSTEMS

The AWR Project consists of several separate phases and activities that require different process controls. The AWR RCS is required to operate continually throughout the waste retrieval operation, prior to any construction activities around and on the silos and during the staging of silo waste in the transfer storage tanks. The silo waste retrieval activities are batch processes and require controls to start, stop, and control operation. To accomplish these multiple functions and activities the AWR Process control philosophy uses two independent control systems. These systems are the Balance of Plant (BOP) control system and the RCS.

The two independent control systems are integrated through a fiber optic cable link and the Siemens Profibus operating system. The primary plant operating system is the BOP control system, which is responsible for total control of plant operations except for the RCS. The RCS is provided with an independent control system but is provided a link to the BOP control system.

The BOP control system does not provide control input signals but does receive and log status and alarm signals from the RCS. In the event of an alarm or status signal requiring action from the RCS, the operator initiates the appropriate human-machine interface (HMI) and takes the necessary action.

4.1.1 System Concept

The AWR BOP Project control system is a PLC-based system with distributive input/output (I/O) data collection and control panels. The PLC and redundant operator HMI stations are located in the control room, which is in Building 94A. The data collection and control panels are located at the silo bridge, high-pressure water pumps, and the TTA building. The distributive I/O data collection and control panels are connected to the PLC by a fiber optic network. The individual equipment items located at the I/O panels are connected to the nearest I/O panel with field wiring.

4.1.2 Control Systems

The AWR Project BOP control system is an integrated system that allows both local control at the equipment site and remote control at the central control room. The AWR Project BOP control systems support operations during SWRS and TWRS waste removal operations, as well as TTA system monitoring.

4.1.3 Silo Maintenance and Control Facility

The control room for the AWR Project is used for the Silos 1 and 2 waste removal and transfer operations. It is located in Building 94A, Silos Operation and Maintenance Building. The control room has an operator station for control of the waste removal, transfer, and support equipment. The control room has wiring distribution for field 120 VAC power and uninterruptible power supply (UPS) 120 VAC power.

4.1.4 Controls Utility Requirements

The following utilities support the AWR Project BOP control systems.

Electrical Power – UPS 120 VAC, single-phase power is provided to the AWR Project control room. UPS 120 VAC, single-phase power is provided to each I/O data collection and control panel. 120 VAC power, single-phase is provided to the control room.

Fiber Optic – Fiber optic cables is installed to the required I/O panels located throughout the site.

Interfaces – Interfaces to equipment systems include the RCS, SWRS, TTA, and TWRS.

Maintenance – The required maintenance on the AWR Project BOP control system is expected to be low. Low maintenance results from using quality components and a modular design within the AWR Project BOP control system.

4.1.5 BOP Control System General Requirements

The AWR Project BOP control system is designed incorporating the following general requirements:

- Safely control the equipment
- Protect the operator
- Allow remote operation of the equipment
- Easy to learn and operate
- Minimize maintenance

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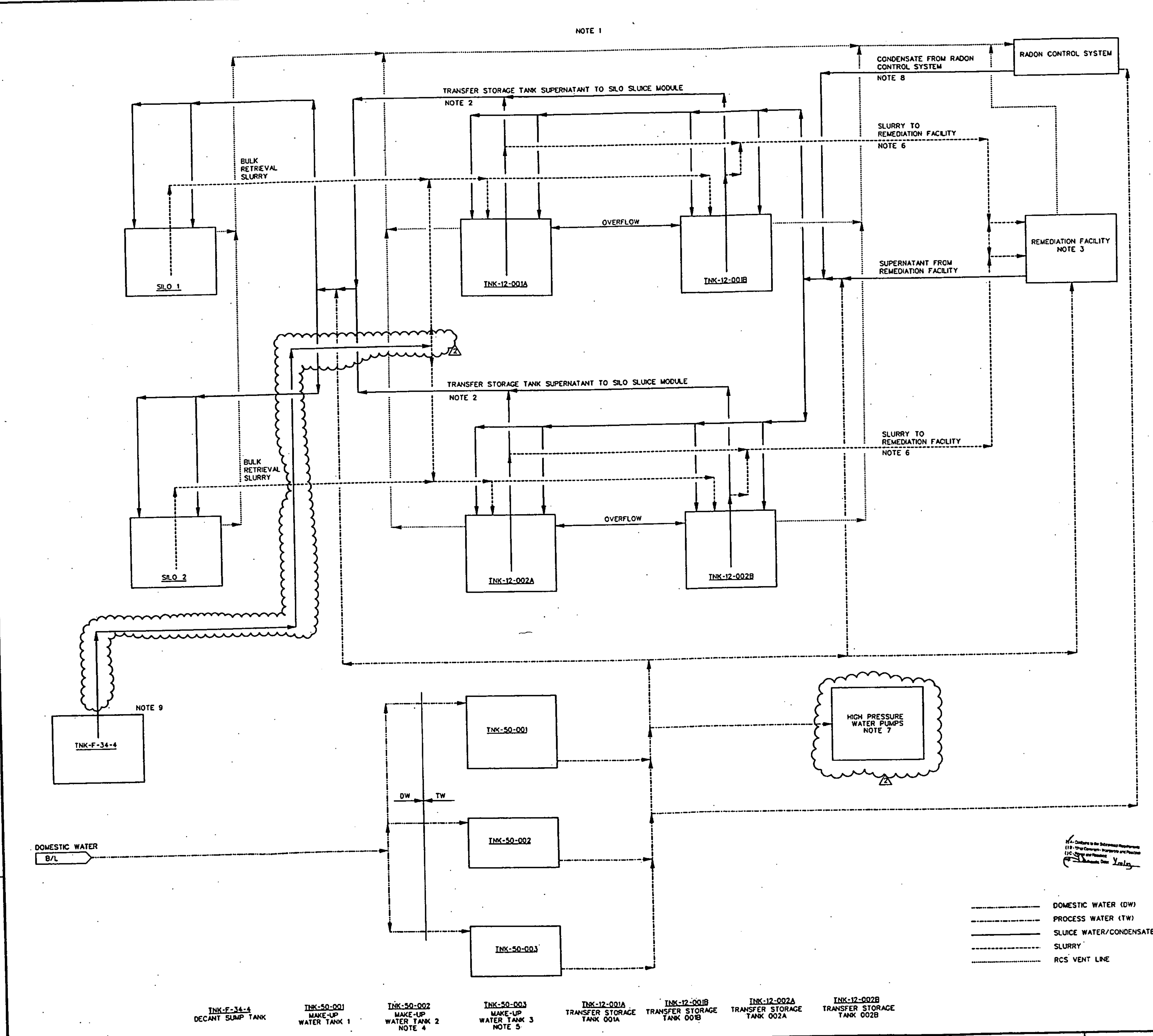

NOTES:

1. THE PROCESS OVERVIEW PROCESS FLOW DIAGRAM DEPICTS PRIMARY FLOW PATHS AND IS NOT INTENDED TO SHOW ACTUAL PIPING CONFIGURATIONS. FOR EXAMPLE, THE ABILITY TO PUMP CONTENTS OF ONE TRANSFER STORAGE TANK TO ANY OTHER TRANSFER STORAGE TANK EXISTS, BUT IS NOT DEPICTED IN THIS DIAGRAM.
2. SLUICE WATER MAY BE PUMPED FROM ANY ONE OF THE TRANSFER STORAGE TANKS IN DECANT MODE.
3. REFER TO SILOS 1 AND 2 PROJECT.
4. PREVIOUSLY TNK-12-003.
5. PREVIOUSLY TNK-12-004.
6. IT IS ANTICIPATED THAT CONTENTS FROM ONLY ONE TRANSFER STORAGE TANK WILL BE TRANSFERRED TO THE REMEDIATION FACILITY AT A TIME.
7. HIGH PRESSURE PUMPS PROVIDING HIGH PRESSURE WATER FOR DECONTAMINATING EQUIPMENT AND SLURRY PUMP SPRAY RINGS ARE SUPPLIED BY THE PROCESS WATER SYSTEM.
8. CONDENSATE IS PUMPED FROM THE RADON CONTROL SYSTEM BUILDING INTO THE VALVE AREA IN THE TTA BUILDING.
9. NO PROCESS FLOW DIAGRAM WAS GENERATED FOR DECANT SUMP TANK.

REF. DWG NO.	DRAWING TITLE

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	DATE	REV. BY	APPR.
2	REVISED PER DCN 40710-JEG-258, 273	12/...	CS	MPM
1	REVISED PER DCN 40710-JEG-181	09/20/02	CS	MPM
0	ISSUED TO CONSTRUCTION	05/29/02	WBC	SWH

INITIALS AND DATE

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
JACOBS

PROJECT NAME
AWR BOP OPTIMIZATION

DRAWING TITLE
FLOW DIAGRAMS
PROCESS FLOW DIAGRAM
PROCESS OVERVIEW

DRAWN BY	DATE	TECHNICAL LEAD	DATE	CHECKED BY	DATE
J.Ferri	05/29/02	M.Malone	05/29/02	W.B.Cartee	05/29/02

PLANT/BLDG. NO.	FLOOR	SCALE	CLASS
		NONE	U

SUBMITTED FOR 30% ISSUE	SUBMITTED FOR 60% ISSUE	SUBMITTED FOR 90% ISSUE
TECH LEAD	TECH LEAD	TECH LEAD
DATE	DATE	DATE

T.O. NUMBER	PROJECT NO.	DRAWING INDEX CODE NO.	SHEET NO.	REV. NO.
N/A	40710	94X-3900-F-01490	F6000	2
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